

Introduction to the symposium "Cephalopods: A behavioral perspective"*

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Behavior is not an area we usually associate with molluscs, and one tends to think instead of vertebrates, especially mammals. Yet when we do think of molluscan behavior, it is the cephalopods that come to mind. With their large centralized brain, reputed high intelligence, efficient physiology, and complex motor output, cephalopods have an excellent basis for complex behavior. Despite this capacity, cephalopod behavior is little known and not well explored, and the authors in this symposium, especially the paper collection, attempt to shine light into various corners with a wide variety of cephalopod subjects.

One of the simplest aspects of behavior is sensory reception, and one of the 'simplest' systems and most molluscan-general is that found in *Nautilus* Linnaeus, 1758. Soucier and Basil discuss a pioneering laboratory investigation of tactile sensitivity in the nautiloids; clearly these deep-sea animals should rely on non-visual information much of the time, but only their chemical sensing has been well investigated. Now that their mechanical reception has been established, further research will no doubt look more at its use in natural situations and the limits of and receptors for its sensitivity.

The programming of motor output, the root of behavior, is similarly simple on the surface. Grasso has tackled the motor output of suckers of *Octopus* Cuvier, 1797 and their combinations to produce actions on the environment. While movement ought to be simple, the use and coordination of hundreds of suckers turns out to be, as befits the complexity of neural support of the suckers, both complex and variable. How much of this programming is central and how much peripheral as well as how the 'reflex' arm control system can perform such complex maneuvers remains to be investigated; again the foundation has been laid for further investigation.

Behavior is linked to the underlying physiology of the animal, and the thoughtful paper by King and Adamo makes sense of the paradoxes in the combination of *Sepia* Linnaeus, 1758 cuttlefish linkage of mantle contraction and blood circulation. The motor action of mantle contraction has a major effect on the circulation of blood through this area, and the authors evaluate why the particular patterns of blood

flow during this major event occur. More of such behavior-physiological linkage is needed, and the King and Adamo paper is a welcome start.

One unique, coleoid cephalopod motor system is responsible for the chromatophore system that produces skin patterns and colors, but its complexity means that it is often characterized only informally. Leite and Mather use a computerized data analysis approach to build the repertoire of one *Octopus* species. Such characterization offers insight into the neural production of patterns and pattern complexity on the skin; in addition, this approach may assist us in taxonomic investigation of the species complex of *Octopus vulgaris* Cuvier, 1797.

Behavior gives us insights into physiology and ecology of animals, and behavior of deep-sea octopods in underwater videos is the subject of the paper by Voigt. Because humans are very limited in their activities in the deep sea, cephalopod research has focused on the easily available near-shore and near-surface species of *Octopus*, *Sepia*, and *Loligo* Lamarck, 1798. Thus, Voigt's insight into how these deep-sea and little-known animals behave is particularly welcome.

The most complex areas of behavior are the emergent aspects such as play, personality, and cognition, studied mainly in *Octopus* so far. Mather covers the research in these areas and suggests that we have much to learn about the intelligence, cognitive capacity, and even possible consciousness in cephalopods. She challenges us to look at behavior of molluscs, particularly in but not limited to cephalopods, for greater underlying subtlety and complexity than we have assumed so far.

In addition to these published papers, other symposium participants presented work on a range of interesting aspects of cephalopod behavior. Huffard discussed octopus mating strategies for *Abdopus* Norman and Finn, 2001; Cosgrove discussed the brooding behavior of *Enteroctopus* Rochebrune and Mabile, 1889. Again with *Enteroctopus dofleini* (Wülker, 1910) as a model, Lyons and Scheel discussed the ecological impact and movement of octopuses in their natural environment. Finally, Williams looked at the chemical defenses of hatchling *Hapalochlaena* Robson, 1929, and Bush discussed why deep-sea squid might ink into the dark.

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